

Doyle Transformer Site Consultation

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HEALTH CONSULTATION

Doyle Transformer Site

Leonard, Texas

Fannin County

March 19, 1999

Prepared by

Texas Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

9457006



Doyle Transformer Site Consultation

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BACKGROUND AND STATEMENT OF ISSUES

The Texas Natural Resource Conservation Commission (TNRCC) requested that the Texas Department of Health (TDH) Health Risk Assessment and Toxicology Program evaluate the potential health risks associated with exposure to soil on and near the Frank J. Doyle Transformer Site in Leonard, Fannin County, Texas. The site is an active registered salvage yard that receives and processes used power transmission transformers for recoverable metals. There is conflicting information as to whether transformers still are being processed on the site. The site is bordered to the north by a residential area, to the east by Leonard High School, to the south by an alleyway and two residences, and to the west by the owner's residence. The alleyway has heavy pedestrian traffic from students of the adjacent Leonard High School. A day care center, which contains outside play areas for children is located southwest of the site across the alley.

We were asked to base our assessment of this site on 19 soil samples collected by the TNRCC in 1998. The TNRCC collected one on-site sample (6-12 inches deep) from each of three identified waste management areas, 13 off-site surface soil samples from various areas of suspected contaminant migration, and three background samples from unaffected areas. In addition to the soils samples, four groundwater samples were collected from two Leonard municipal water wells and one privately owned drinking water well. Samples were analyzed for pesticides, polychlorinated biphenyls (PCBs), semi-volatile and volatile organic chemicals, and metals.

DISCUSSION

Based on a review of the laboratory results, the primary contaminant of concern for the site is the PCB Aroclor 1260 (Table 1). This contaminant was found at high concentrations in soil both on- and off- the site (Figure 1). The highest on-site concentration of Aroclor 1260 (2,300 mg/kg) was found in soil from a low area north of the concrete pad container storage area. The highest off-site concentration of Aroclor 1260 (4,100 mg/kg) was found in soil collected from the alleyway south of the site. Soil samples from the daycare center and the high school did not contain significant levels of PCBs (Table 1; Figure 1). Many of the sample results were reported either as "estimated values" or as values that were "not recommended for use because of associated QA/QC performance inferior to that from other analysis" [2]. Several of the samples which contained extremely high levels of Aroclor 1260, required dilutions beyond that which the laboratory was capable of performing. None of the groundwater samples contained significant quantities of pesticides, PCBs, semi-volatile and volatile organic chemicals or metals.

Health Assessment Comparison Values

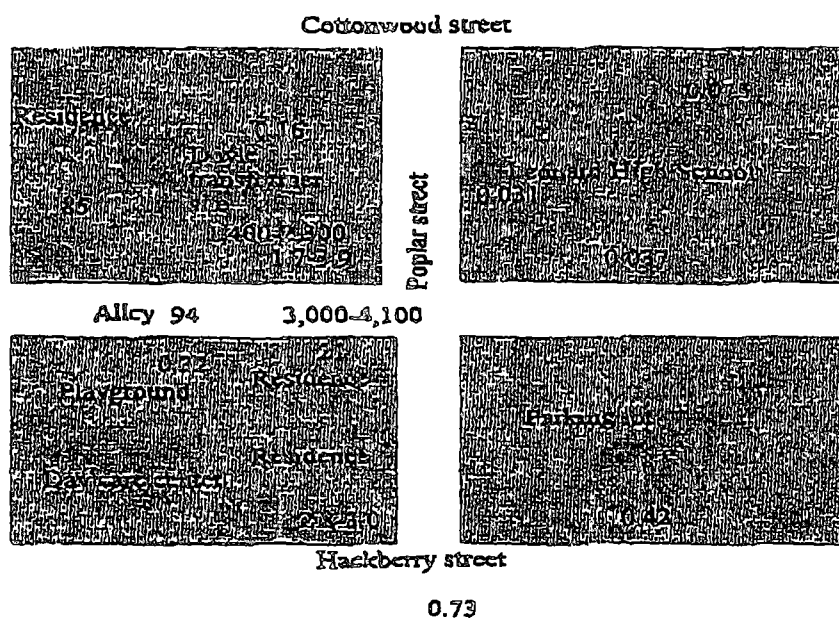
To assess the potential health risks associated with exposure to Aroclor 1260 in soil, we compared the reported concentrations to health assessment comparison (HAC) values for non-carcinogenic and carcinogenic endpoints. Currently, there are no HAC values specifically for Aroclor 1260 [1]. We based the non-cancer comparison value for Aroclor 1260 on the Agency for Toxic Substances and Disease Registry's (ATSDR's) minimal risk level (MRL) for the

Doyle Transformer Site Consultation

Draft for Certification

structurally similar compound Aroclor 1254. The MRL is an estimate of a daily human exposure to a contaminant that is unlikely to cause adverse non-cancer health effects over a lifetime. We based the cancer risk comparison value for Aroclor 1260 is on the U.S. Environmental Protection Agency's (EPA's) cancer slope factor for PCBs as class of chemicals and an estimated excess lifetime cancer risk of one-in-one million persons. Exceeding a HAC value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration. Although many of the concentrations were reported as estimated values, they were well above health based comparison values (Table 1).

Figure 1. Doyle transformer site and soil sample concentration of Aroclor 1260 (mg/kg)



Polychlorinated Biphenyls (PCBs)

Background

PCBs are a group of synthetic organic chemicals that contain 209 individual chlorinated biphenyl compounds (known as congeners) with varying harmful effects. They are either oily liquids or solids and are colorless, odorless, and tasteless. There are seven common types of commercially available PCB mixtures, also known as "Aroclors", which constitute 98% of PCBs sold in the United States since 1970. The name Aroclor 1254 means that the molecule contains 12 carbon atoms (first two digits) and approximately 54% chlorine by weight (second two digits). The more highly chlorinated Aroclors have been found to have greater potential for adverse health effects in humans and animals. There are no known natural sources of PCBs in the environment. Typical concentrations in soil are less than 10 to 40 $\mu\text{g/kg}$ [3].

Doyle Transformer Site Consultation

Draft for Certification

Because they don't burn easily and are good insulating materials, PCBs have been used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because of evidence that they build up in the environment and cause harmful health effects. Today, PCBs can be released into the environment from poorly maintained hazardous waste sites that process used electrical transformers or by burning of organic wastes in municipal and industrial incinerators.

Environmental Fate

PCBs released into the environment bind strongly to soil and sediments and may remain there for several years to many decades. The more highly chlorinated congeners, such as Aroclor 1260 do not typically travel deep into the soil with rainwater. Because of strong adherence to soil, migration of the highly chlorinated PCBs to groundwater and volatilization to air are negligible.

Currently, the major source of PCB release to the atmosphere is the redistribution of the compounds already present in soil and water. Aroclors are no longer produced in the U.S.; however, emissions may be discharged into the air from other sources including disposal sites containing transformer and capacitor PCB wastes, incineration of waste, and improper disposal or spills of the compounds to open areas. PCB vapors remain in air for an average of more than ten days, and once in the air they can be carried for very long distances from where they were released into the environment. Vapors eventually return to the land and water by settling or washout with snow and rain. The higher chlorinated PCBs, such as Aroclor 1260, are more likely to be associated with the particulate adsorption phase in air than are the lower chlorinated PCBs [3].

In water, a small amount of PCBs may remain dissolved, but most tends to stick to organic particles and sediments. PCBs in water can build up in fish and marine animals at concentrations hundreds of thousands of times higher than the concentration in water. One of the most significant sources of PCB exposure by humans is through the ingestion of contaminated fish, shellfish, meat, or dairy products [3].

Toxicological Evaluation

PCBs are absorbed through ingestion, inhalation and dermal routes, after which they are transported similarly through the circulation. Once they enter the body, they may be stored in body fat and the liver for many months. They also can build up in milk fat and can enter the bodies of infants through breastfeeding.

Health Effects - Non-Cancer

The most common health effect observed in persons exposed to PCBs is a form of skin irritation known as chloracne. Other health effects that have been reported in humans include general weakness, numbness of the limbs, respiratory symptoms, altered immune response, and damage to the liver. Gastrointestinal effects such as anorexia, weight loss, nausea, vomiting, and abdominal pain have been observed in workers exposed to PCBs. Ingestion of PCBs and/or swallowing inhaled PCB particles may have contributed to these effects [3].

Doyle Transformer Site Consultation

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It is not known whether PCBs can cause birth defects in humans; however, some studies indicate that consumption of PCB contaminated fish during pregnancy can be associated with decreased birth weight, gestational age, and head circumference of infants, as well as a decrease in learning abilities that continued later in life. In the majority of the developmental studies, co-exposure to chemicals other than PCBs and differences in lifestyle were not accounted for. Animal studies have conclusively shown PCBs to cause birth defects such as abortions, stillbirths, and underweight offspring. A number of studies have reported an association between consumption of PCB contaminated fish by women during and before pregnancy and subsequent neurodevelopmental effects in their infants. Limitations to these studies include comparability of exposed to control subjects and exposure assessment. In a group of 242 infants born to mothers who either ate fish from Lake Michigan which was contaminated with PCBs and those who did not, a weak correlation was found between PCB levels in the umbilical cord and altered behavioral responses which persisted until testing ended at age 11. Postnatal exposure from breastfeeding was not related to behavioral performance [3].

Other effects observed in animals include increased hepatic microsomal enzyme induction, liver enlargement, fat deposition, fibrosis, and necrosis, increased cholesterol (animals), thyroid enlargement with decreased production of thyroid hormones, increased adrenal gland production reported as an adaptive response to stress, facial edema, acne, fingernail loss, loss of hair in monkeys, weight loss, and kidney damage. However, the levels necessary to produce those effects were very high and it is not known if the same effects would happen in people exposed chronically to lower levels [1].

Inhalation of PCBs by workers employed in capacitor facilities has been observed to cause upper respiratory tract or eye irritation, cough, headaches, and tightness of the chest. Hepatic effects, such as increases in levels of serum liver related enzymes may be related to inhalation of PCB particles [1].

The Agency for Toxic Substances and Disease Registry (ATSDR) has established a chronic oral minimum risk level (MRL) of 0.00002 mg/kg/day for Aroclor 1254. This MRL is based on a study in which a decrease in functioning of the immune system was observed in rhesus monkeys fed with the compound in a mixture of corn oil for a period of 55 months. At 55 months, there was a significant dose-related decrease in IgM titers in response to challenges with sheep red blood cell antigens. The lowest dose level tested, 0.005 mg/kg/day, was considered the lowest observable adverse effects level (LOAEL) for decreased antibody response. Studies in species other than monkeys have given inconclusive immunologic findings in that changes in some immune parameters were sporadic, generally not dose-related, or occurred at much higher levels. Weak correlations between PCB exposure and depressed immunological function, specifically a reduction in natural killer (NK) cells, have been found in humans consuming PCB contaminated fish; however, these studies are confounded by the coinciding presence of DDT, which also is capable of affecting the immune system. The uncertainty factors considered in this study include ten for use of a LOAEL, three for extrapolation from animals to humans, and ten for human variability [3].

Doyle Transformer Site Consultation

Draft for Certification

Health effects - Cancer

Studies in animals show that PCB's containing 60% chlorine by weight are clearly carcinogenic and indicate differences in the carcinogenic potential of other PCB mixtures, based on the degree of chlorination. Available data suggest that the carcinogenic potency decreases with the percent chlorination. Hepatocellular (liver) carcinomas developed in rats fed an estimated dose of 5 mg/kg/day Aroclor 1260 for 21 months [1].

Animals treated intermediately or chronically with Aroclors 1254 or 1260 showed statistically increased incidences of liver adenomas and carcinomas. To investigate hepatic tumor progression after exposure has stopped, groups of rats were exposed for 52 weeks, then exposure was discontinued for an additional 52 weeks. For Aroclor 1260, the "stop-study" tumor incidences were greater than those of the lifetime study, indicating persistent biological activity after exposure stops for the more highly chlorinated Aroclors. Other cancers observed in animals include thyroid gland carcinomas, adenocarcinoma of the stomach, leukemia and lymphoma [1].

A human study analyzing cancer mortality among 2,100 workers at a capacitor manufacturing plant in Italy found statistically significant increases in death from cancers of the gastrointestinal tract and blood system compared with national and local rates [4]. Another human study involving 2,588 workers at two capacitor plants in the U.S. have found significant increases in death from cancer of the liver, gall bladder, and biliary tract [5]. Studies of associations between serum PCBs and hepatic indices in environmentally exposed populations are generally inconclusive due to the elimination of other contributing factors such as lifestyle, occupational exposures, or consumption of PCB contaminated foods.

Although studies of workers do not provide enough information to determine if PCBs cause cancer in humans, based on the animal studies, the Department of Health and Human Services (DHHS) has determined that PCBs may reasonably be anticipated to be carcinogens. The International agency for Research on Cancer (IARC) and the EPA each have determined that PCBs are probable human carcinogens. The EPA has estimated an oral cancer slope factor of 2.0 (mg/kg/day)⁻¹ for PCB mixtures [1].

Public Health Implications

The primary exposure pathway considered in this consultation is the possible ingestion of contaminated soil from the unpaved gravel alley between the site and the adjacent day care center and high school; TNRCC personnel reported heavy pedestrian traffic by students from of the high school. We also considered exposure to contaminated soil from each of the residences that were sampled. Inhalation of contaminated dust could be a potential route of exposure; however, we would not anticipate it to be a major route of exposure.

Based upon the data that were available for review, we calculated an exposure dose matrix for 60 potential exposure scenarios (Table 2). These scenarios include potential exposures to PCBs found in soil from the alley and soil from each of the three residences that were sampled. Based

Doyle Transformer Site Consultation

Draft for Certification

on a conservative estimate of exposure, the MRL could be exceeded at each of these locations. While exceeded an MRL does not necessarily imply a threat to public health, it is noteworthy that in some instances the estimated exposures are less than an order of magnitude lower than the observed LOAEL for immunological effects in primates. Since the observed LOAEL was the lowest dose tested, the actual LOAEL could be considerably lower.

Assuming an average body weight of 50 kg (high school age teenager), an exposure period of 196 days per year (excludes summer months) for four years, and an average of one hour possible contact time per day (time spent in the alleyway; daily ingestion rate adjusted based on contact time), we estimate that there would be no apparent increase in the lifetime risk of developing cancer.

Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also are smaller, resulting in higher doses of chemical exposure per body weight [6]. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The TDH evaluated the potential for children living in the vicinity of the Doyle Transformer Site to be exposed to polychlorinated biphenyls at levels of health concern. Currently children are not likely to be chronically exposed to contaminants at this site; however, infrequent contact is possible.

Doyle Transformer Site Consultation

Draft for Certification

Table C. Soil samples collected from the Doyle Transformer Site		
Sample	Location	Aroclor 1260 concentration (ppm)
		Non-cancer HAC value for Aroclor 1254 = 1 ppm (child) and 10 ppm (adult); Cancer HAC value for 2,3,7,8-PCB = 0.4 ppm
SO-01	Upgradient from site - background sample	non-detectable
SO-02	Upgradient from site - background sample	0.033 ^{oo}
SO-03	Upgradient from site - background sample	3.4 ^{vv}
SO-04	5-part composite sample 0-6" deep from grassy area just north of Leonard High School	0.073 ^{oo}
SO-05	5-part composite sample 0-6" deep from grassy area just west of Leonard High School	0.031 ^{oo}
SO-06	5-part composite sample 0-6" deep from grassy area just south of Leonard High School	0.037 ^{oo}
SO-07	grab sample from the drainage ditch along Hackberry Street east of Poplar Street	0.42 ^{vv}
SO-08	grab sample from the east drainage ditch located along Poplar Street south of Hackberry Street	0.73 ^{oo}
SO-09	grab sample from the east drainage ditch located along Poplar Street south of Hackberry Street	2.9 ^{oo}
SO-10	duplicate of SO-09	3.0 ^{oo}
SO-11	grab sample from a low spot in the NE corner of the newest residential yard adjacent to the site	21 ^o
SO-12	5-part composite sample 0-6" deep from the backyard of a former day care center adjacent to the site	0.32 ^{oo}
SO-13	grab sample from the public alleyway located south of the site's perimeter fence	94 ^{oo}
SO-14	grab sample from the public alleyway located south of the site's perimeter fence	3,000 ^{oo}
SO-15	duplicate of SO-14	4,100 ^{oo}
SO-16	grab sample collected from a low area along the east fence line of an adjacent residential yard	85 ^{oo}
SO-17	grab sample collected from the transformer off-load area located north of the shop	0.16 ^{oo}
SO-18	grab sample collected from a low area north of the concrete pad container storage area	1,400 and 2,300 (in dilution sample) ^o
SO-19	grab sample collected from a low area west of the transformer storage area in the SE corner of the site	1.7 and 3.1 (in dilution sample) ^o

^oNon-cancer HAC value derived from the EPA RSD and ATSDR MRL of 0.0002 mg/kg/day for Aroclor 1254. Cancer HAC value derived from EPA's oral slope factor of 2 (mg/kg/day)⁻¹ for polychlorinated biphenyls. Assumes a body weight of 10 kg for children and 70 kg for adults and a soil consumption rate of 100 mg for adults and 200 mg for children.

^oresult not recommended for use because of associated QA/QC performance inferior to that from other analysis

^{oo}estimated value

Doyle Transformer Site Consultation

Draft for Certification

Table 2: Exposure Dose Matrix for Doyle Transformer Site (mg/kg/day)						
Soil concentration = 4,100 mg/kg Aroclor 1260 in the alleyway (High school student exposure scenario assumes exposure occurs 1 hour per day, 196 days per year. Soil ingestion rate adjusted to reflect one-hour exposure)						
Body Weight (kg)	Age Range	Soil Ingestion Rate (mg/24 hours)				
		25	50	100	150	200
30	teen	4.8x10 ⁻⁵	9.6x10 ⁻⁵	1.9x10 ⁻⁴	2.9x10 ⁻⁴	3.8x10 ⁻⁴
60	teen	2.4x10 ⁻⁵	4.8x10 ⁻⁵	9.6x10 ⁻⁵	1.4x10 ⁻⁴	1.9x10 ⁻⁴
70	adult	2.1x10 ⁻⁵	4.2x10 ⁻⁵	8.4x10 ⁻⁵	1.2x10 ⁻⁴	1.7x10 ⁻⁴
Soil concentration = 21 mg/kg Aroclor 1260 from the residence immediately south of the site						
15	3-6	1.5x10 ⁻⁵	3.0x10 ⁻⁵	6.0x10 ⁻⁵	9.0x10 ⁻⁵	1.2x10 ⁻⁴
35	10-11	1.5x10 ⁻⁵	3.0x10 ⁻⁵	6.0x10 ⁻⁵	9.0x10 ⁻⁵	1.2x10 ⁻⁴
70	adult	7.5x10 ⁻⁶	1.5x10 ⁻⁵	3.0x10 ⁻⁵	4.5x10 ⁻⁵	6.0x10 ⁻⁵
Soil concentration = 3 mg/kg Aroclor 1260 from the second residence south of the site						
15	3-6	5.0x10 ⁻⁶	1.0x10 ⁻⁵	2.0x10 ⁻⁵	3.0x10 ⁻⁵	4.0x10 ⁻⁵
35	10-11	2.1x10 ⁻⁶	4.3x10 ⁻⁶	8.6x10 ⁻⁶	1.3x10 ⁻⁵	1.7x10 ⁻⁵
70	adult	1.1x10 ⁻⁶	2.1x10 ⁻⁶	4.3x10 ⁻⁶	6.4x10 ⁻⁶	8.6x10 ⁻⁶
Soil concentration = 85 mg/kg Aroclor 1260 from the Doyle residence						
15	3-6	1.4x10 ⁻⁴	2.8x10 ⁻⁴	5.6x10 ⁻⁴	8.4x10 ⁻⁴	1.1x10 ⁻³
35	10-11	6.0x10 ⁻⁵	1.2x10 ⁻⁴	2.4x10 ⁻⁴	3.6x10 ⁻⁴	4.8x10 ⁻⁴
70	adult	3.0x10 ⁻⁵	6.0x10 ⁻⁵	1.2x10 ⁻⁴	1.8x10 ⁻⁴	2.4x10 ⁻⁴

Shaded areas represent exceedance of the MRL/RfD of 2x10⁻⁵ mg/kg/day

Doyle Transformer Site Consultation

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CONCLUSIONS

1. Overall, exposure to soil on and around the Doyle Transformer Site poses a public health hazard because of the presence of the PCB Aroclor 1260 in the soil. Chronic ingestion of small amounts of soil from around this site could result in exposure doses that exceed EPA's reference dose and ATSDR's minimum risk level. Given the level of uncertainty surrounding the lowest effects level observed in primate studies upon which the RfD and MRL are based, it is possible that exposure to PCBs in soil near this site could result in adverse health outcomes.
2. Soil contaminated with PCB Aroclor 260 has migrated to the alleyway south of the Doyle Transformer Site as evidenced by the very high levels of PCBs were measured in soil from the alleyway. Students from the adjacent Leonard High School frequent this alleyway during the normal school year. Chronic exposure to this soil could pose a public health hazard.
3. Soil on the Doyle Transformer Site contains elevated levels of PCBs; particularly high levels were found near the concrete slab used for processing transformers. The resident on site could be exposed to PCBs in the soil at concentrations that pose a health hazard.
4. Soil from the two residential yards immediately south of the site contains PCBs at levels well above background. Chronic ingestion of these soils by small children or adults could pose a public health hazard.
5. The low levels of PCBs found in soil from Leonard High School and from the day care center south of the site do not pose a public health hazard.

RECOMMENDATIONS

1. Soil from the alleyway between the Doyle Transformer Site and the daycare should be removed.
2. The PCB contaminated soil around the concrete pad container storage area on the site should be removed and future processing activities should be monitored to prevent further contamination.
3. The PCB contaminated soil from the two residential yards immediately south of the alleyway should be removed and replaced with clean soil.

Doyle Transformer Site Consultation

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Doyle Transformer Site Consultation

Draft for Certification

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Doyle Transformer Site Consultation

Draft for Certification

CERTIFICATION

This Health Consultation was prepared by the Texas Department of Health under the a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated.

Technical Project Officer, SPS, RPB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

Director, DHAC, ATSDR